

42. (New) The laser device of claim 37 wherein said undoped spacer layer comprises two sub-layers of quaternary materials having different compositions, each of said two or more sub-layers having a bandgap-wavelength in the range of 0.92 – 1.1 μm .

43. (New) The semiconductor device of claim 37 wherein said semiconductor layers are formed by MOCVD.

REMARKS

The above amendments are made in response to the first substantive Office Action mailed April 19, 2002, wherein:

1. Claims 1-3, 5-15, 17-21, and 23-29 were rejected under 35 U.S.C. §102(b) as being anticipated by U.S. Patent No. 4,701,774 to McIlroy, *et al.*, (referred to herein as “the McIlroy patent”);
2. Claims 1-4, 6, 11, 20-22, and 28-30 were rejected under 35 U.S.C. §102(b) as being anticipated by U.S. Patent No. 4,585,491 to Burnham, *et al.*, (referred to herein as “the Burnham patent”); and
3. Claims 4, 16, 22, and 30 was rejected under 35 U.S.C. §103(a) as being obvious over the McIlroy patent in view of the Burnham patent.

Applicants have provided amendments to overcome the above rejections. Below, Applicants provide reasons as to why the amended claims are allowable over the cited prior art. **Claims 1-30, and new Claims 31 - 43 are pending in the application.**

Support for Amendments to the Claims

Housekeeping amendments have been made to Claim 29 to more clearly label the first III–V semiconductor layer and the second III–V semiconductor layer, and to clarify aspects of the MOCVD process.

Claims 1, 12, and 20 have been amended to indicate that the optical confinement layer is undoped. Claim 29 has been amended to indicate that the layer formed directly over the spacer layer is formed from undoped material. Claim 30 has been amended to indicate that the layer

deposited directly over the spacer layer is undoped. Support for these amendments appears on page 6, lines 23-24 of the Specification.

Claims 1, 12, and 20 have been further amended to indicate that the spacer layer is in contact with the cladding layer, and in contact with the optical confinement layer. Claim 29 has been amended to indicate that the second III-V semiconductor layer (*e.g.*, optical confinement layer) is formed directly on the spacer layer. Claim 30 has been amended to indicate that an undoped layer of semiconductor material (*e.g.*, optical confinement layer) is formed directly on the spacer layer. These amendments are supported by FIG. 2, which shows spacer layer 8 in contact with an undoped optical confinement layer 3, and in contact with cladding layer 2.

Claim 1 has been amended to recite a light generating layer disposed over the optical confinement layer, and first and second electrodes for supplying electrical current to the light generating layer. Claim 20 has been amended to recite the formation of the electrodes. These amendments are supported by FIG. 2 of the application and its description thereof in the Specification, and by original Claim 12 of the application. Similar to this, Claim 29 has been amended to recite a first electrode and second electrode for sending an electrical current through the semiconductor layers, and Claim 30 has been amended to recite the formation of the electrodes. These amendments are similarly supported by FIG. 2 of the application and its description thereof in the Specification, and by original Claim 12 of the application.

Claims 2, 13, and 28 have been amended to indicate that the spacer layer has a thickness which is less than the thickness of the cladding layer. Support for this amendment appears on page 7, lines 8-14, where exemplary embodiments disclose spacer layers with thicknesses of 3 nm, 5 nm, 10 nm, 20 nm, and 500 nm and a doped cladding layer with a thickness of 1 μm (=1,000 nm).

Applicants respectfully submit that no new matter is entered by these amendments.

Response to the Rejection of Claims 1-3, 5-15, 17-21 and 23-29 over the McIlroy Patent

In the Office Action, independent Claims 1, 12, and 20 and their respective dependent Claims 2-3, 5-11, 13-15, 17-20, 21, and 23-28 were rejected under 35 U.S.C. §102(b) as being anticipated by the McIlroy patent. Independent Claim 29 was similarly rejected, and independent Claim 30 was rejected based on a combination of the McIlroy and Burnham patents. With this Amendment, independent Claims 1, 12, and 20 have been amended to indicate that the optical confinement layer is undoped and is in contact with the undoped spacer layer. Claims 29

and 30 have been amended to indicate that the layers formed directly on the spacer layers are formed by deposition of undoped material. In contrast, the McIlroy patent discloses a doped layer 42 which is contact with the layer that the Examiner has corresponded to Applicants' spacer layer. The doping in layer 42 is an essential feature of the McIlroy invention, and is used to cancel internal electric fields near the active layer (McIlroy patent, column 4, lines 33-53). Accordingly, its removal would destroy the McIlroy invention and therefore would not be obvious. In addition, its removal would destroy the correspondence that the Examiner has constructed between the McIlroy patent and the rejected claims. For these reasons, Applicants respectfully submit that independent Claims 1, 12, and 20 and their corresponding dependent claims are novel and non-obvious over the McIlroy patent.

In addition, Applicants respectfully submit that there is no teaching from the Burnham patent which can modify the McIlroy patent to anticipate Claim 30 without destroying the essential feature of the McIlroy patent, or without destroying the correspondence that the Examiner has constructed between the McIlroy patent and the Claim 30. Applicants apply these same reasons in response to the rejection of dependent claims 4, 16, and 22.

Finally, Applicants respectfully note the McIlroy patent and Claims 1-3, 5-15, 17-21 and 23-29 of the present invention are directed toward different lasers. The McIlroy patent is directed to low-power signal lasers where fast modulation of the laser output with low modulation noise is important (e.g., optical output power of less than 40 mW) (McIlroy patent, column 1, lines 25-35). In contrast, Claims 1-3, 5-15, 17-21 and 23-29 of the present invention are directed toward enabling high power pumping layers which are not modulated to convey signal information (e.g., optical output power of 200 mW and more).

Response to the Rejection of Claims 1-4, 6, 11, 20-22, 28-30 over the Burnham Patent

In the Office Action, independent Claims 1 and 20 and their respective dependent Claims 2-4, 6, 11, and 21-22 were rejected under 35 U.S.C. §102(b) as being anticipated by the Burnham patent. Independent Claims 29 and 30 were similarly rejected. With this Amendment, independent Claims 1 and 20 have been amended to recite the presence of electrodes for supplying current to the light generating layer or active layer. Independent Claims 29 and 30 have been similarly amended to recite the presence of electrodes for sending an electrical current through the semiconductor layers.

The structure used by the Examiner to reject these claims is shown in FIG. 1 of the

undoped cladding section is thicker than its thin doped cladding section, the Burnham patent does not anticipate the above feature of amended Claims 2, 13 and 28. Applicants further respectfully submit that it would not be obvious to reduce the thicknesses of Burnham's undoped cladding sections since this modification would reduce or destroy its function of allowing the potential of the inner layers 12, 14, and 16 to change in response to the pumping light, and would reduce or destroy its function of electrically isolating the inner layers from the outer doped cladding sections.

Applicants respectfully submit these reasons as additional reasons for the patentability of Claims 2, 13, and 28 over the Burnham patent.

New Claim 31

New Claim 31 is supported by page 7, lines 15-17 of the present application. Accordingly, Applicants respectfully submit that no new matter is entered by this claim.

The interruption of the MOCVD process is not taught or suggested by either of the McIlroy and Burnham patents.

New Claims 32-25

New dependent Claims 32-35 recite that the semiconductor optical confinement layer comprises a quaternary compound. These claims are supported by the specification at page 6, lines 23-34. Accordingly, Applicants respectfully submit that no new matter is entered by these claims.

In their work, Applicants have found that quaternary semiconductor materials are difficult to epitaxially grow with good quality and low defects, particularly by MOCVD onto doped cladding layers, as would be done if a quaternary semiconductor material were used to form the lower optical confinement layer of a semiconductor laser device. In such a case, Applicants have found that acceptable quantum-well layers are difficult to grow on these quaternary optical confinement layers, making it difficult to produce laser devices with acceptable quality and yield. On the other hand, Applicants have found that the spacer layer accordingly to the present invention, disposed between the doped cladding layer and the quaternary optical confinement layer, significantly reduces the defects in quaternary optical confinement layers and significantly increases the quality of these layers and the quantum well layers formed thereover, and that the resulting laser devices have good yield and good quality.

Both the patents to McIlroy and Burnham use ternary optical confinement layers, which do not substantially have the above noted defect and quality problems.

New Claim 36

New Claim 36 is original Claim 10 rewritten in independent form. This claim recites that the undoped spacer layer comprises a strain compensated superlattice layer. The layers in the McIlroy and Burnham patents which the Examiner has corresponded to the spacer layer of rejected Claim 10 are unstrained layers, and therefore cannot be strain compensated superlattice layers. Moreover, there are no benefits discernable from the McIlroy and Burnham patent for having any strain in the layers that the Examiner has corresponded to the spaced layer of rejected Claim 10. For these reasons, Applicants respectfully submit that new Claim 36 and original Claim 10 are novel and nonobvious over the patents to McIlroy and Burnham.

New Claim 37

New Claim 37 recites original Claim 1, plus the features of (1) the spacer layer being undoped, (2) the semiconductor optical confinement layer comprising a quaternary compound, (3) a light-generating layer disposed over the optical confinement layer, and (4) first and second electrodes for supplying an electrical current to the light generating layer. Support for feature 1 appears on page 6, lines 23-24 of the Specification. Support for feature 2 appears at page 6, lines 23-34 of the Specification. Support for features 3 and 4 is found in FIG. 2 of the application and its description thereof in the Specification, and by original Claim 12 of the application. Accordingly, Applicants respectfully submit that no new matter is entered by new Claims 37. Claim 37 provides the benefits described above with respect to new Claim 32-35 that are achieved with use of the undoped spacer layer formed below a quaternary optical confinement layer.

New Claim 38 recites the subject matter recited by amended Claim 2 (but is dependent upon Claim 37), and is supported by the original specification and claims on the same bases. Accordingly, Applicants respectfully submit that no new matter is entered by new Claim 38.

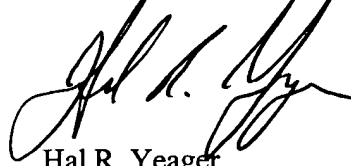
New Claims 39, 40, 41, 42, and 43 recite the subject matters of original Claims 4, 7, 8, 9, and 11, respectively. Accordingly, these claims are supported by the original claims. Accordingly, Applicants respectfully submit that no new matter is entered by new Claims 39-43.

CONCLUSION

In view of the remarks made above, applicants respectfully submit that the application is in condition for allowance and action to that end is respectfully solicited. If the Examiner should feel that a telephone interview would be productive in resolving issues in the case, he is invited to telephone the undersigned at the number listed below after 11:00 a.m. PST (2:00 EST).

Attached hereto is a marked-up version of the changes made to the claims by the current amendment. The attached page is captioned "Version with markings to show changes made".

Respectfully submitted,



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“Version with Markings to Show Changes Made”

Additions are shown by **bold underlining**, deletions are shown between **[brackets and in bold type]**.

In the Claims:

Claims 1, 12, 13, 20 and 28-30 have been amended as follows:

1. **(Once Amended)** A semiconductor laser device, comprising:
 - a doped semiconductor cladding layer;
 - [a] an undoped** semiconductor optical confinement layer; **[and]**
an undoped semiconductor spacer layer positioned between said cladding layer and said optical confinement layer **and in contact with both said cladding layer and said optical confinement layer;**
a light-generating layer disposed over said optical confinement layer; and
a first electrode and second electrode for supplying an electrical current to said light generating layer.

2. **(Once Amended)** The laser device of claim 1, wherein said undoped spacer layer has a thickness **which is less than the thickness of said cladding layer and which is** [of] more than about 4 nm.

12. **(Once Amended)** A semiconductor laser device, comprising:
 - a semiconductor substrate;
 - an n-doped semiconductor lower cladding layer;
 - [a] an undoped** semiconductor lower optical confinement layer;
 - an undoped semiconductor spacer layer between said lower cladding layer and said lower optical confinement layer **and in contact with both said cladding layer and said optical confinement layer;**
 - a semiconductor active layer for generating light;
 - a semiconductor upper optical confinement layer;
 - a p-doped semiconductor upper cladding layer; and
 - electrodes for current injection to said device.

13. (Once Amended) The laser device of claim 12, wherein said undoped spacer layer has a thickness which is less than the thickness of said cladding layer and which is [of] more than about 4 nm.

20. (Once Amended) A method of making a semiconductor laser device, comprising the steps of:

forming an n-doped semiconductor lower cladding layer on a substrate;

forming an undoped semiconductor spacer layer over said lower cladding layer and in contact therewith;

forming [a] an undoped semiconductor optical confinement layer over said spacer layer and in contact therewith; [and]

forming an active, light emitting semiconductor layer over said optical confinement layer, and

forming a first electrode and a second electrode for supplying an electrical current to said active, light emitting semiconductor layer.

28. (Once Amended) The laser device of claim 20, wherein said undoped spacer layer has a thickness which is less than the thickness of said cladding layer and which is [of] more than about 4 nm.

29. (Once Amended) A semiconductor device comprising:

a first [n-doped] III – V semiconductor layer formed by MOCVD of n-doped semiconductor material,

[an undoped] a III – V semiconductor spacer layer formed by MOCVD of undoped semiconductor material deposited directly on said [n-doped] first III – V semiconductor layer,

a second III – V semiconductor layer formed [over] by deposition of undoped

semiconductor material directly on said spacer layer, whereby lattice defects caused by said [n-doped] first III – V semiconductor layer are mitigated by said spacer layer, and
a first electrode and second electrode for sending an electrical current through said
III-V semiconductor layers.

30. (Once Amended) A method of making a III – V semiconductor device, comprising the steps of:

depositing a layer of a III – V semiconductor compound doped with selenium using MOCVD;

depositing a spacer layer of an undoped III – V semiconductor compound directly on said selenium-doped layer using MOCVD;

depositing an [active] undoped layer comprising one or more III – V semiconductor compounds [over] directly on said spacer layer, and

forming a first electrode and second electrode for sending an electrical current
through said layers.